NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 3210 FINAL EXAM 12/96 Prof. Powers

- This exam is open book and notes.
- There are four problems; each is equally weighted.
- Partial credit will be given; be sure to do some work on each problem.
- Be sure to include units in your answers.
- Please circle or underline your answers.
- Do *NOT* do any work on this sheet.
- Show *ALL* work.
- Enter your name in the space provided.
- Exams and course grades *should* be available outside the Optical Electronics Laboratory (Bu 224) on **Friday afternoon, 20 December**.
- Have a good holiday season and enjoy your break!

Course grade: _____

1		3	
2		4	
TOTAL			

Name: _____

1. A Gaussian beam (at $\lambda = 1$ μm) at the input to a lens with a focal length of 40 cm has a spot size, w_1, of 8 mm and a radius of curvature, R_1, of +80 cm.

   (a) Find the spot size, w_2, and the radius of curvature, R_2, at the output of the lens.

   (b) Find the spot size, w_3, and the radius of curvature, R_3, in a plane locate a distance of R_2 to the right of the lens.

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2. Consider an air-gap scanning Fabry-Perot interferometer with a mirror separation of 5 cm that is used to scan the 3.39 μm line of a HeNe laser. The mirror reflectivities are 99.00%.

   (a) If the linewidth of the laser output is expected to be 0.01 nm, calculate the required distance that the end mirror of the interferometer has to move to measure the laser linewidth.

   (b) Find the ratio of the frequency linewidth of the interferometer's transmissivity to the frequency linewidth of the laser.

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3. Consider a carbon-monoxide laser that lases at 6.0 μm. Assume that $n = 1.1$ for carbon monoxide.

   (a) Find the Doppler-broadened linewidth of this laser operating at a temperature of 350K.

   (b) Find the saturation irradiance, assuming that the Doppler broadening is dominant.

   (c) If the unsaturated gain coefficient is 0.15 m^{-1}, find the saturated gain coefficient when the output irradiance is 5 $\mathrm{W/m}^2$ and the output mirror reflectivity is 80%.

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4. Consider a Q-switched, excimer laser that is a three-level laser operating at 350 nm. The laser medium dimensions are 1 cm x 1 cm x 15 cm and the molecular density is 10^{30} molecules/m^3. The pump is able to excite three-fourths of the molecules into the upper level of the transition before the Q-switch switches the losses. The index of refraction of the medium is 1.0 and the reflectivities of the laser mirrors are 100% and 92%.

   (a) Calculate the energy in the Q-switched pulse.

   (b) Calculate the peak power of the pulse.